

# A Complete Description of *Sepia mira* (Cotton 1932) (Cephalopoda: Sepiidae) from Eastern Australia

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*Sepia mira* (Cotton 1932) is described on the basis of five specimens trawled between 20–72 m off northern New South Wales. The species was known previously only from cuttlebones collected from a number of eastern Australian localities. This complete description confirms the status of *S. mira* as valid.

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KEY WORDS: *Sepia mira*, Sepiidae, doratosepion, description, eastern Australia.

## INTRODUCTION

*Sepia mira* was described by Cotton (1932) on the basis of a cuttlebone collected on North-West Islet in the Capricorn Group of Islands off Gladstone, Queensland. Since that time, bones have been collected from additional localities in New South Wales (NSW) and Queensland, but whole animals had remained elusive. In 1995 and 1996, Ken Graham from NSW Fisheries collected some representatives of this species near the Clarence River mouth in northern New South Wales, enabling the species to be fully described here. The specimens were collected as part of a NSW Fisheries survey of the Newcastle and Clarence River prawn grounds. Other sepiids collected within the range of *S. mira* were: *S. apama* Gray 1849; *S. limata* (Iredale 1926) (see endnote); *S. opipara* (Iredale 1926); *S. plangon* Gray 1849 and *S. rozella* (Iredale 1926), with the latter two species occurring in the greatest abundance (Graham and Wood 1997).

Cotton (1932) decided that *Sepia mira* was sufficiently distinctive to place in a new genus, *Tenuisepia*. Subsequent workers (with the notable exception of Iredale and McMichael (1962) who placed the species in its own subfamily) have generally concluded that distinct generic status is not justified. Until a complete revision of the sepiids is undertaken, the classification followed here is that proposed in Khromov et al. (in press) which recognises only three genera within the Sepiidae with the present species designated to the genus *Sepia*.

This complete description confirms the status of *S. mira* as valid.

## MATERIALS AND METHODS

This work was based on museum material. All material studied is listed in the *Material Examined* section. Institutional acronyms used are: AM — Australian Museum, Sydney, Australia; MV — Museum of Victoria, Melbourne, Australia and SAM — South Australian Museum, Adelaide, Australia. Other abbreviations: coll. — collected, F — female, FV — Fisheries Vessel, Is. — Island, J — juvenile, m — meters, M — male, mm — millimeters.

TABLE 1

Description of measurements and counts. Definitions largely follow Roper and Voss (1983). New or modified definitions are indicated by an asterisk (\*). Indices (shown in square brackets) are calculated by dividing each measure by mantle length or, for cuttlebone characters, cuttlebone length (unless otherwise specified).

- Arm Length — **AL**: length of each designated (i.e. 1,2 etc.) arm measured from first basal (proximal-most) sucker to distal tip of arm (Arm 1, dorsal; 2, dorso-lateral; 3, ventro-lateral; 4, ventral) [**ALI**].
- Anterior Mantle to Head length \* — **AMH**: dorsal length of mantle measured from anterior-most point of mantle to intersection of transverse line joining dorso-lateral mantle margin [**AMHI**].
- Arm Sucker Count \* — **ASC**: total number of suckers on each designated arm (e.g. ASC2).
- Arm Sucker diameter — **AS**: diameter of largest sucker on each designated (i.e. 1,2 etc.) arm [**ASIn**]. Suckers on left ventral hectocotyliised arms are differentiated as follows:
- Arm Sucker left 4 \* — **ASl4**: diameter of largest sucker on left ventral arm of male [**ASInl4**].
- Cuttlebone Breadth — **CbB**: greatest dorso-ventral breadth of cuttlebone. [**CbBI**]
- Cuttlebone Length — **CbL**: dorsal length of cuttlebone along midline, including spine.
- Cuttlebone Width — **CbW**: greatest width of cuttlebone [**CbWI**].
- Club Length — **CIL**: length of tentacular club measured from proximal-most basal suckers (carpus) to distal tip of club [**CILI**].
- Club Row Count — **CIRC**: number of suckers in transverse rows on tentacular club.
- Club Sucker diameter — **CIS**: diameter of largest sucker on tentacular club [**CISI**].
- Club Sucker dorsal \* — **CISd**: diameter of largest tentacular club sucker in dorsal-most (closest to swimming keel) longitudinal row [**CISId**].
- Club Sucker ventral \* — **CISv**: diameter of largest tentacular club sucker in ventral-most (opposite swimming keel) longitudinal row [**CISIv**].
- Eye Diameter — **ED**: diameter of eye [**EDI**].
- Egg Length \* — **EgL**: length of egg [**EgLI**].
- Free Funnel length — **FFu**: the length of the funnel from the anterior funnel opening to the point of its dorsal attachment to the head [**FFuI**].
- Fin Insertion anterior \* — **FIA**: anterior origin of fin measured from mantle margin to anterior-most junction of fin and mantle [**FIIa**].
- Fin Insertion posterior\* — **FIP**: measured between posterior junctions of fins with mantle [**FIIp**].
- Funnel Length — **FuL**: the length of the funnel from the anterior funnel opening to the posterior margin measured along the ventral midline [**FuLI**].
- Fin Width — **FW**: greatest width of single fin [**FWI**].
- Gill Lamellae Count — **GiLC**: number of lamellae on outer demibranch including the terminal lamella.
- Gill Length \* — **GiL**: length of gill [**GiLI**].
- Head Length — **HL**: dorsal length of head measured from point of fusion of dorsal arms to anterior tip of nuchal cartilage [**HLI**].
- Head Width — **HW**: greatest width of head at level of eyes [**HWI**].
- Locus Length \* — **LoL**: length of the last locus (ventral anterior smooth zone of the cuttlebone) [**LoLI**].
- Mantle Length — **ML**: dorsal mantle length. Measured from anterior-most point of mantle to posterior apex of mantle.
- Mantle Width — **MW**: greatest straight-line ventral width of mantle [**MWI**].
- Spine Length \* — **SL**: length of spine [**SLI**].
- Spermatophore Length — **SpL**: length of spermatophore [**SpLI**].
- Spermatophore Width — **SpW**: greatest width of spermatophore. Spermatophore width index is expressed as a percentage of spermatophore length [**SpWI**].
- Striated Zone length — **StZ**: length of striated zone of cuttlebone [**StZI**].
- Transverse Row Count — **TrRC**: number of suckers in longitudinal series on tentacular club [counted from proximal-most basal suckers (carpus) to distal tip of club].
- Ventral Mantle Length — **VML**: length of ventral mantle measured from anterior mantle margin at ventral midline, to posterior apex of mantle [**VMLI**].

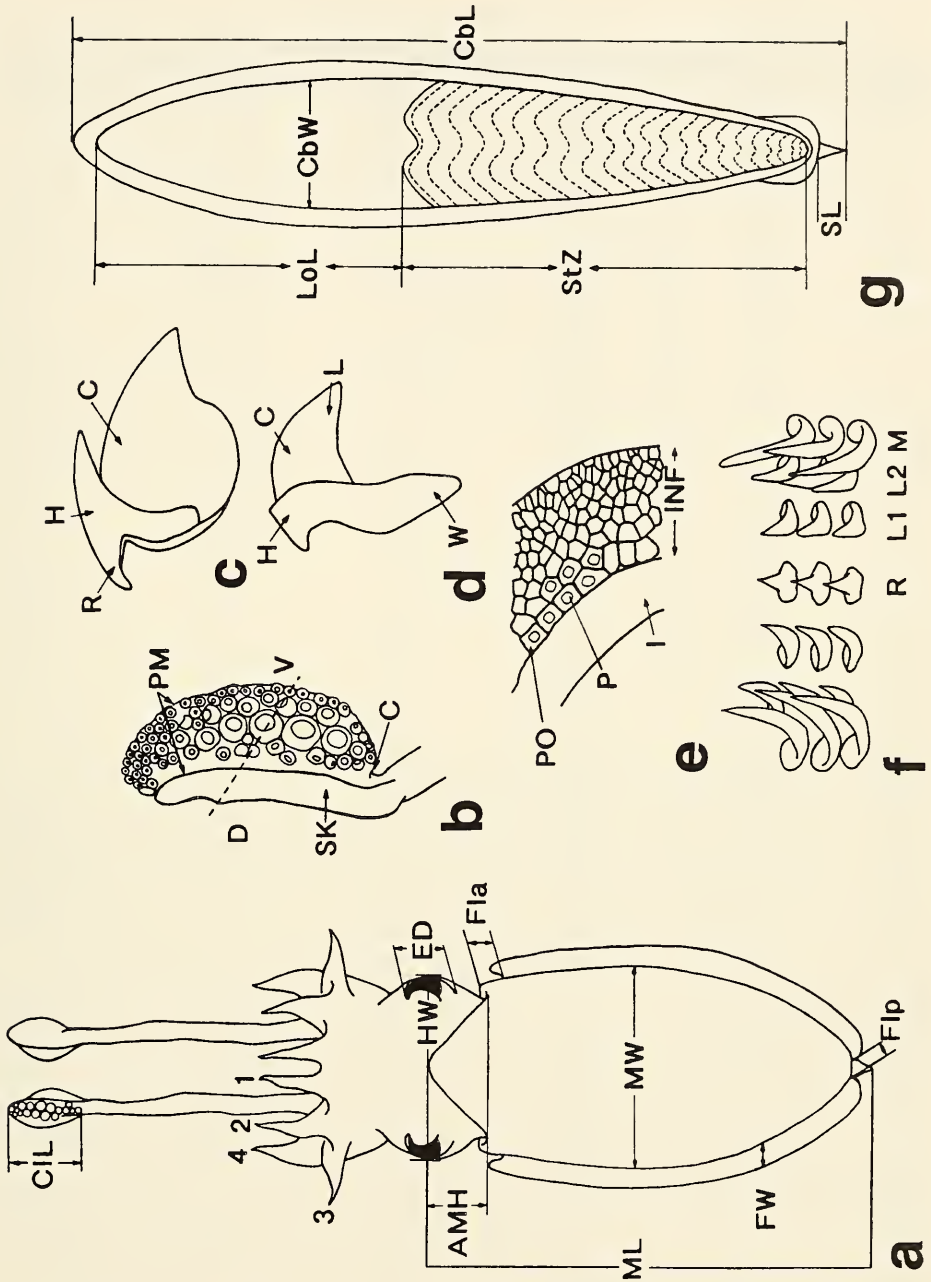


Figure 1. Measurements and Terminology: (a) whole animal dorsal view (for abbreviations and definitions see Table 1); (b) tentacular club (C — carpus, D — dorsal, PM — protective membranes, SK — swimming keel, V — ventral). The number of suckers intersected in an oblique transverse line across the club, shown as a hatched line on this figure, is the Club Row Count (CIRC) [In the example illustrated CIRC = 4]; (c) upper beak (C — crest, H — hood, R — rostrum); (d) lower beak (C — crest, H — hood, L — lateral wall, W — wing); (e) arm sucker rim (I — inner ring, INF — infundibulum, PO — polygonal process, P — peg); (f) radula (R — rhachidian teeth, L1 — first lateral teeth, L2 — second lateral teeth, M — marginal teeth); (g) cuttlebone, ventral view (for abbreviations and definitions, see Table 1). [(a) and (g) modified from Roper and Voss (1983) Figure 1].

TABLE 2

Measurements (mm), counts and indices of 3 male and 2 female *Sepia mira* (Cotton). M — male, F — female.

Museum Reg. No.	MV F80995	MV F80996	AM C306764	MV F80997	AM C306387
	M	M	M	F	F
ML	38.1	42.7	44.0	43.0	43.9
MWI	43.8	39.3	43.2	46.7	45.6
AMHI	11.0	12.6	12.3	9.3	10.9
VMLI	85.3	84.3	83.6	90.0	80.6
FWI	6.3	8.4	8.4	9.3	7.5
FIIa	6.3	2.8	5.7	5.1	4.6
FIIp	4.7	3.3	4.5	12.3	9.6
FuLI	26.1	29.5	25.7	29.1	28.5
FFuI	11.8	10.5	14.8	9.3	9.1
HLI	27.1	23.0	22.3	22.6	28.5
HWI	31.5	32.3	30.7	34.7	31.9
EDI	12.6	10.8	10.5	10.5	8.0
ALI1	31.5	31.6	25.0	34.9	27.3
ALI2	30.2	29.3	36.4	32.6	31.9
ALI3	31.5	25.8	31.8	31.4	37.6
ALI4	39.4	37.5	38.6	39.5	36.4
ASIn1	0.84	1.03	1.02	1.12	1.03
ASIn2	1.05	1.03	1.14	1.05	1.03
ASIn3	1.05	1.17	1.25	1.12	1.25
ASIn4	1.18	0.94	1.18	1.28	1.25
ASC1	80	78	90	90	82
ASC2	60	82	95	92	82
ASC3	60	78	110	103	98
ASC4	92	122	104	116	110
ASInl4	1.05	0.70	1.14	—	—
CILI	11.8	11.2	10.0	10.0	—
CIRC	3	3	3	3	—
TrRC	16	13	17	20	—
CISI	1.34	1.41	1.36	0.93	—
CISId	0.63	0.63	0.80	0.56	—
CISIV	0.39	0.35	0.34	0.37	—
GiLC	—	26	—	24	—
GiLI	28.3	28.3	34.1	30.0	27.3
SpLI	7.9	6.6	6.6	—	—
SpWI	5.33	5.71	4.14	—	—
EgDI	—	—	—	5.8	7.3
CbL	39.9	47.9	44.0	51.4	45.1
CbWI	22.8	22.1	22.7	23.7	22.0
CbBI	7.0	7.3	7.9	5.8	7.3
SLI	3.9	3.4	2.7	4.5	3.3
StZI	69.6	63.9	66.6	72.8	67.2
LoLI	21.0	28.8	30.5	20.2	30.8
LoL/StZ (%)	30.2	45.1	45.7	27.1	45.9



TABLE 3

*Sepia mira* (Cotton); ranges of arm length indices (ALI), arm sucker diameter indices (ASIn) and arm sucker counts (ASC) of 3 mature males and 2 mature females. min. = minimum, max. = maximum, SD = standard deviation.

	Males				Females			
	min.	mean	max.	SD	min.	mean	max.	SD
ALI1	25.0	<u>29.4</u>	31.6	3.8	27.3	<u>31.1</u>	34.9	5.3
ALI2	29.3	<u>31.9</u>	36.4	3.9	31.9	<u>32.2</u>	32.6	0.5
ALI3	25.8	<u>29.7</u>	31.8	3.4	31.4	<u>34.5</u>	37.6	4.4
ALI4	37.5	<u>38.5</u>	39.4	1.0	36.4	<u>38.0</u>	39.5	2.2
ASIn1	0.84	<u>0.96</u>	1.03	0.11	1.03	<u>1.07</u>	1.12	0.06
ASIn2	1.03	<u>1.07</u>	1.14	0.06	1.03	<u>1.04</u>	1.05	0.02
ASIn3	1.05	<u>1.16</u>	1.25	0.10	1.12	<u>1.18</u>	1.25	0.10
ASIn4	0.94	<u>1.10</u>	1.18	0.14	1.25	<u>1.27</u>	1.28	0.02
ASC1	78	<u>83</u>	90	6	82	<u>86</u>	90	6
ASC2	60	<u>79</u>	95	18	82	<u>87</u>	92	7
ASC3	60	<u>83</u>	110	25	98	<u>101</u>	103	4
ASC4	92	<u>106</u>	122	15	110	<u>113</u>	116	4

Measurements and indices used throughout this paper are primarily those given in Roper and Voss (1983), using dorsal mantle length (ML) as a size standard. Some additional measurements are used, and these with the definitions listed by Roper and Voss (1983) are given in Table 1. Parts of the club and arm sucker rims are described using the terminology of Nixon and Dilly (1977), while nomenclature for the radula follows Nixon (1995). Beaks were described following Clarke (1986). Diagrammatic illustrations of measurements and terminology used for key structures are shown in Fig. 1.

Measurements were made either using dial callipers, or an eyepiece micrometer attached to a stereo microscope. All measurements are expressed in millimetres (mm). Measurements and counts for individual specimens are shown in Table 2. Ranges of arm length indices, arm sucker diameter indices, and arm sucker counts are presented in Table 3; ranges for all other characters appear in the text. In species descriptions and tables, the range of values for each character is expressed as: minimum — mean — maximum (standard deviation, SD). Values for each sex are given separately.

Measurements for structures which were clearly distorted or broken were not attempted, and these, in addition to missing values, appear as a dash (–) in the tables. Ranges for specific character traits given with the species description do not, therefore, always refer to the total number of specimens examined.

For examination of arm and club sucker rims, suckers were removed from the middle of designated arms and the tentacular club, mounted in glycerine jelly and viewed using a compound microscope. Radulae and beaks were dissected from the buccal mass, and soaked for approximately 30 minutes in a warm, saturated potassium hydroxide solution, then radulae were cleaned using forceps and a fine brush. Radulae were also mounted in glycerine jelly, and the new, unused portion was examined.

The species description was generated by the DELTA (Description Language for Taxonomy) system (Dallwitz 1980; Dallwitz et al. 1993; Partridge et al. 1993).

*Sepia mira* (Cotton 1932)  
(Figures 2–9, Tables 2 & 3)

### Synonymy

*Tenuisepia mira* Cotton 1932: 546–547, figs 7–9.—Iredale 1954: 75, pl. V, figs 7 & 8.—Iredale & McMichael 1962: 99.

*Sepia mira*.—Adam & Rees 1966: 87.—Nesis 1982: 119, fig. 24X.—Lu & Phillips 1985: 25.

### Material examined

*Holotype*: Australia: Queensland, North-West Is. — cuttlebone (55 mm CbL), 23°18'S, 151°42'E, coll. W.J. Kimber, (SAM D10507). *Additional Material*: Australia: Queensland — 5 cuttlebones (41.5–42.5 CbL), Lizard Is., Coconut Beach, 14°40'S 145°28'E, 10 Oct 1982, coll. R. Burn, (MV F80999); cuttlebone (37.3 CbL), Heron Is., 23°26'S 151°55'E, 1988, coll. A. Reid & P. Ward, (MV F80998). New South Wales — 1F (43.0 mm ML), Clarence R., 29°19'S 153°29'E — 29°20'S 153°29'E, 49–48 m, 19 Apr 1996, coll. K. Graham on FV “Kapala” K960638, (MV F80997); 1M (44.0 mm ML), Off Iluka, 29°20'S 153°25'E — 29°19'S 153°25'E, 37–34 m, 29 May 1995, coll. K.J. Graham on FV “Kapala” K950620, (AM C306764); 1M (42.7 mm ML), Clarence R., 29°22'S 153°23'E — 29°23'S 153°23'E, 28–20 m, 31 Aug 1995, coll. K. Graham on FV “Kapala” K951131, (MV F80996); 1M (38.1 mm ML), Clarence R., 29°50'S 153°20'E — 29°48'S 153°20'E, 37–33 m, 10 Apr 1996, coll. K. Graham on FV “Kapala”, K960602 (MV F80995); 1F (43.9 mm ML), off Woolli, 29°49'S 153°27'E — 29°48'S 153°27'E, 72–69 m, 18 May 1995, coll. K. Graham on FV “Kapala”, K950604 (AM C306387); cuttlebone (48 mm CbL), Trial Bay, 30°53'S 153°04'E, coll. M. Ward, (AM C133312).

### Diagnosis

Cuttlebone oblong; spine with ventral keel; striated zone convex; anterior striae slightly convex to straight; sulcus very shallow, narrow; last loculus very short; inner cone limbs straplike anteriorly, narrower, thicker posteriorly; outer cone posterior lateral limbs flared ventro-laterally. Arm suckers tetraserial. Tentacular club suckers differ in size, 3–4 enlarged suckers toward posterior end of club; 3 suckers in transverse rows; dorsal and ventral protective membranes not fused at base of club; swimming keel extends beyond carpus. [Modified from the original description by Cotton (1932, p. 546)].

### Description

Counts and indices for individual specimens are given in Table 2; ranges for arm length indices, arm sucker diameter indices and arm sucker counts are shown in Table 3.

Small to moderate-sized species (Fig. 2); ML males 38.1–41.6–44.0 (SD, 3.1), females 43.0–43.5–43.9 (SD, 0.6). Mantle oblong; MWI males 39.3–42.1–43.8 (SD, 2.4), females 45.6–46.2–46.7 (SD, 0.8); dorsal anterior margin triangular, acute; extending to level of posterior margin of eyes; AMHI males 11.0–12.0–12.6 (SD, 0.8), females 9.3–10.1–10.9 (SD, 1.2). Ventral mantle margin weakly convex; VMLI males 83.6–84.4–85.3 (SD, 0.8), females 80.6–85.3–90.0 (SD, 6.6). Fins widest in posterior third; FWI males 6.3–7.7–8.4 (SD, 1.2), females 7.5–8.4–9.3 (SD, 1.3); anterior origin posterior to mantle margin; FIIa males 2.8–4.9–6.3 (SD, 1.9), females 4.6–4.9–5.1 (SD, 0.3); rounded posteriorly; narrow gap between fins; FIIP males 3.3–4.2–4.7 (SD, 0.8), females 9.6–10.9–12.3 (SD, 2.0). Funnel long, broad-based; extends to level of anterior



Figure 2. *Sepia mira*: left, cuttlebone dorsal view (posterior end at top); right, freshly caught animal dorsal view, cuttlebone removed, male MV F80996, 42.7 mm ML [photo K. Graham].

rim of eye; FuLI males 25.7–27.1–29.5 (SD, 2.1), females 28.5–28.8–29.1 (SD, 0.4). Funnel free portion approximately one-third funnel length; FFuI males 10.5–12.4–14.8 (SD, 2.2), females 9.1–9.2–9.3 (SD, 0.1). Funnel organ dorsal elements inverted V-shape with small anterior papilla; ventral elements oval (Fig. 3a). Mantle-locking cartilage curved, with semicircular ridge; funnel-locking cartilage with depression which corresponds to ridge (Fig. 3b). Head short (Fig. 2); HLI males 22.3–24.1–27.1 (SD, 2.6), females 22.6–25.5–28.5 (SD, 4.2); slender, narrower than mantle; HWI males 30.7–31.5–32.3 (SD, 0.8), females 31.9–33.3–34.7 (SD, 2.0). Eyes moderate size; EDI males 10.5–11.3–12.6 (SD, 1.2), females 8.0–9.2–10.5 (SD, 1.8); ventral eyelids present (anterior half of eye only).

Male arms 4 slightly longer than other arms, arms 1–3 all similar length, not elongate (Table 3). Female arm lengths subequal (Table 3). ALI of longest arms in males (ALI4) 37.5–38.1–38.6 (SD, 0.8), females (ALI4) 36.4–38.0–39.5 (SD, 2.2). Protective membranes (both sexes) narrow; normal, not thickened. Distal arm tips (both sexes) not markedly attenuate. Arm suckers tetraserial in both sexes. Suckers in males normal in size (not greatly enlarged); similar to female arm suckers in size (Table 3). Chitinous



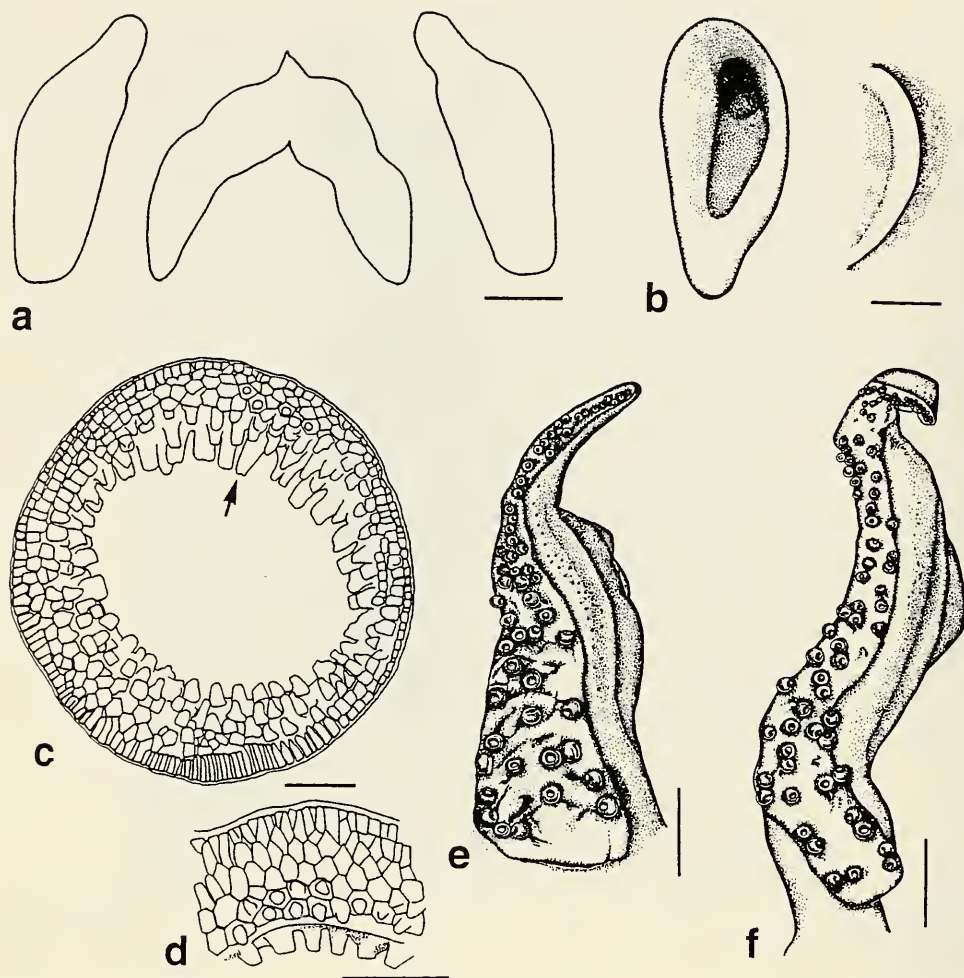


Figure 3. *Sepia mira*: (a) funnel organ, male, MV F80996, 42.7 mm ML, scale bar 2 mm; (b) funnel locking cartilage (left), and mantle locking cartilage (right), female, MV F80997, 43 mm ML, scale bar 2 mm; (c) sucker rim arm 2, scale bar 50  $\mu$ m, arrow indicates elongate teeth on distal margin of inner ring; (d) enlargement of sucker rim arm 2, scale bar 50  $\mu$ m; (e) hectocotylus, left arm 4, scale bar 2 mm; (f) right arm 4, scale bar 2 mm. (a-b & e-f, male MV F80995, 38.1 mm ML).

rims of arm suckers with elongate rectangular teeth on distal half of inner ring, teeth much smaller on proximal half of ring; infundibulum with 4–5 rows of hexagonal processes, inner 2–3 rows with elongate rounded pegs on distal half, becoming smaller towards periphery of sucker, shorter pegs on proximal half as for inner ring; peripheral sucker rim processes radially arranged, elongate, without pegs (Figs 3c and 3d). Sucker counts range from 60–122; females with higher average counts than males (Table 3).

Hectocotylus present, left ventral arm modified (see remarks); sucker size slightly reduced proximally; suckers equal in size across rows, maximum sucker diameters: ASI<sub>nl</sub>4 0.70–0.96–1.14 (SD, 0.23) (compare with right ventral arm, Table 3). Oral surface of modified region wide, fleshy, with transversely grooved ridges (Fig. 3e, compare with Fig. 3f); without distinct median furrow.



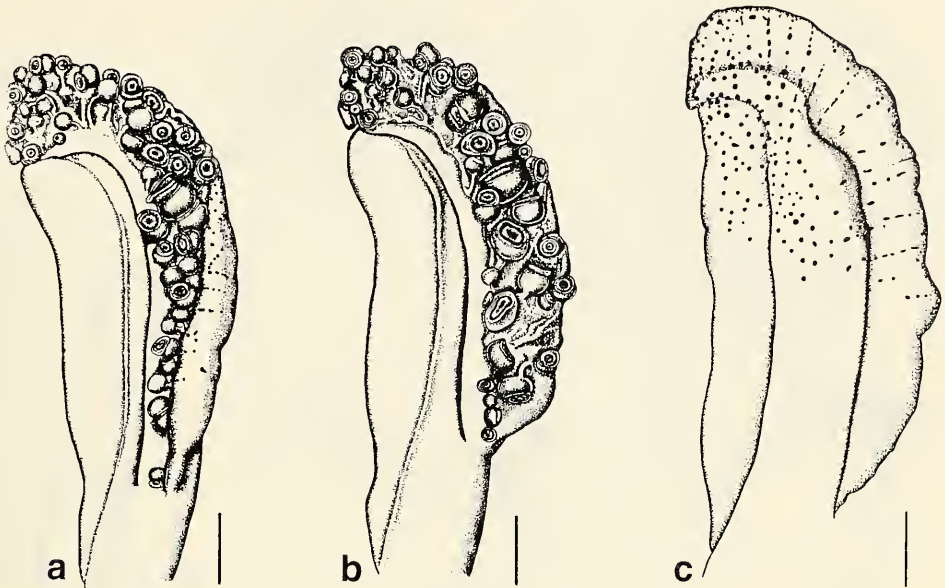


Figure 4. *Sepia mira*: (a) tentacular club, oral view; (b) tentacular club, oral view, dorsal protective membrane pinned back to show sucker arrangement; (c) tentacular club, aboral view. (a-c, female, MV F80997, 43.0 mm ML, scale bars 2 mm).

Tentacular club similar length in males and females; CILI males 10.0–11.0–11.8 (SD, 0.9), female 10. Club crescent-shaped; sucker-bearing face flattened (in all specimens examined, posterior half to two thirds of the club is folded toward dorsal side, ventral protective membrane covering posterior suckers, Fig. 4a). Club with 3 suckers in transverse rows in both sexes; 13–20 suckers in longitudinal series, TrRC males 13–15–17 (SD, 2), female 20. Suckers differ markedly in size, 3–4 enlarged suckers towards posterior end of club (Fig. 4b); CISI males 1.34–1.37–1.41 (SD, 0.03), female 0.93; dorsal and ventral marginal longitudinal series of suckers differ slightly in size; dorsal marginal longitudinal series of suckers slightly larger than those in ventral marginal series; CISId males 0.63–0.69–0.80 (SD, 0.09), female 0.56; CISIv males 0.34–0.36–0.39 (SD, 0.03), female 0.37. Sucker dentition: half inner ring circumference in both sexes with elongate rectangular teeth, remaining half with blunt projections; infundibulum with 3–4 rows of hexagonal processes, innermost with elongate rounded pegs, pegs smaller towards periphery of sucker; at periphery, processes smaller, elongate-rectangular, without pegs (Figs 5a and 5b) (similar to arm suckers). Swimming keel of club extends well beyond carpus. Dorsal and ventral protective membranes not fused at base of club; joined to stalk; dorsal and ventral membranes same length, terminate at posterior end of carpus (Figs 4a and 4b); approximately equal width (Fig. 4c); dorsal membrane forms shallow cleft at junction with stalk.

Gills with 24–26 lamellae per demibranch; GiLC in only intact male 26, 24 in only intact female. Gill length: GiLI males 28.3–30.3–34.1 (SD, 3.3), females 27.3–28.7–30.0 (SD, 1.9).

Buccal membrane without suckers. Upper beak (Fig. 5c) rostrum sharply pointed, long, length greater than width, cutting edge slightly curved; hood high above crest posteriorly; crest curved, lateral wall shallowly indented posteriorly; wings narrow and short; jaw angle approximately 90 degrees, slightly acute; hood dark brown, lighter on ventral

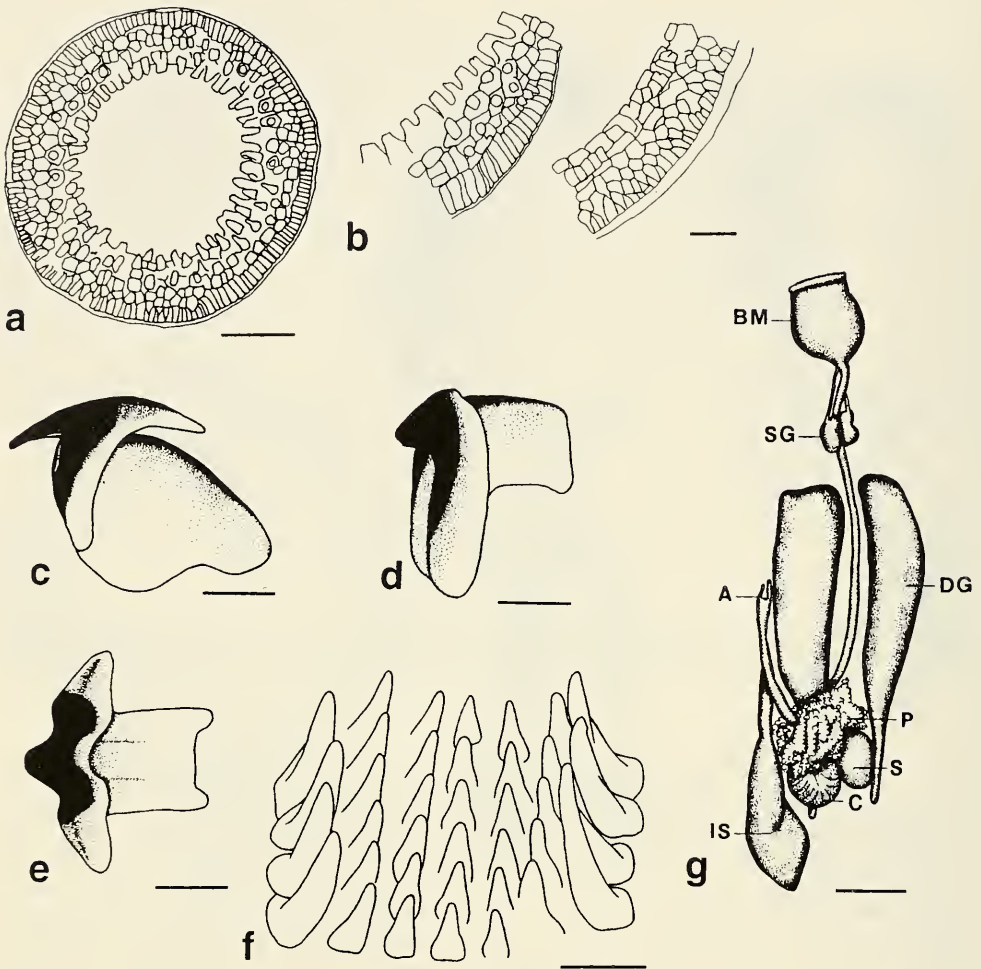


Figure 5. *Sepia mira*: (a) club sucker rim, large club sucker, scale bar 100  $\mu\text{m}$ ; (b) enlargements of large club sucker rim, scale bar 50  $\mu\text{m}$ ; (c) upper beak, side view; (d) lower beak, side view; (e) lower beak, ventral view; (f) radula, male, MV F80996, 42.7 mm ML, scale bar 200  $\mu\text{m}$ ; (g) digestive tract, dorsal view, scale bar 500  $\mu\text{m}$  (A — anus; BM — buccal mass; C — caecum; DG — digestive gland; IS — ink sac; P — pancreas; S — stomach; SG — salivary gland). (a–b & g, male MV F80995, 38.1 mm ML; c–e, female, MV F80997, 43.0 mm ML. scale bars 3 mm).

margin, crest only slightly pigmented. Lower beak (Fig. 5d) rostrum protrudes only slightly, cutting edge curved; hood low on crest; crest straight, no indentation on lateral wall edge; hood and wings, width narrow; hood notch deep, broad (Fig. 5e); wings widely spaced; crest wide; rostrum pigmented dark brown, wings and crest only slightly pigmented. Radula homodont; rhachidian teeth with narrow, truncate bases, slender, triangular, sides slightly concave (Fig. 5f); first lateral teeth similar length and width to rhachidian teeth, asymmetrical with mesocone slightly displaced toward centre of radula; second laterals longer than first, distinctly curved on lateral margin, with broad heels; marginal teeth elongate with long tapered and curved mesocone (Fig. 4f). Digestive tract: (Fig. 5g) paired salivary glands approximately one-third length of buccal mass; paired digestive

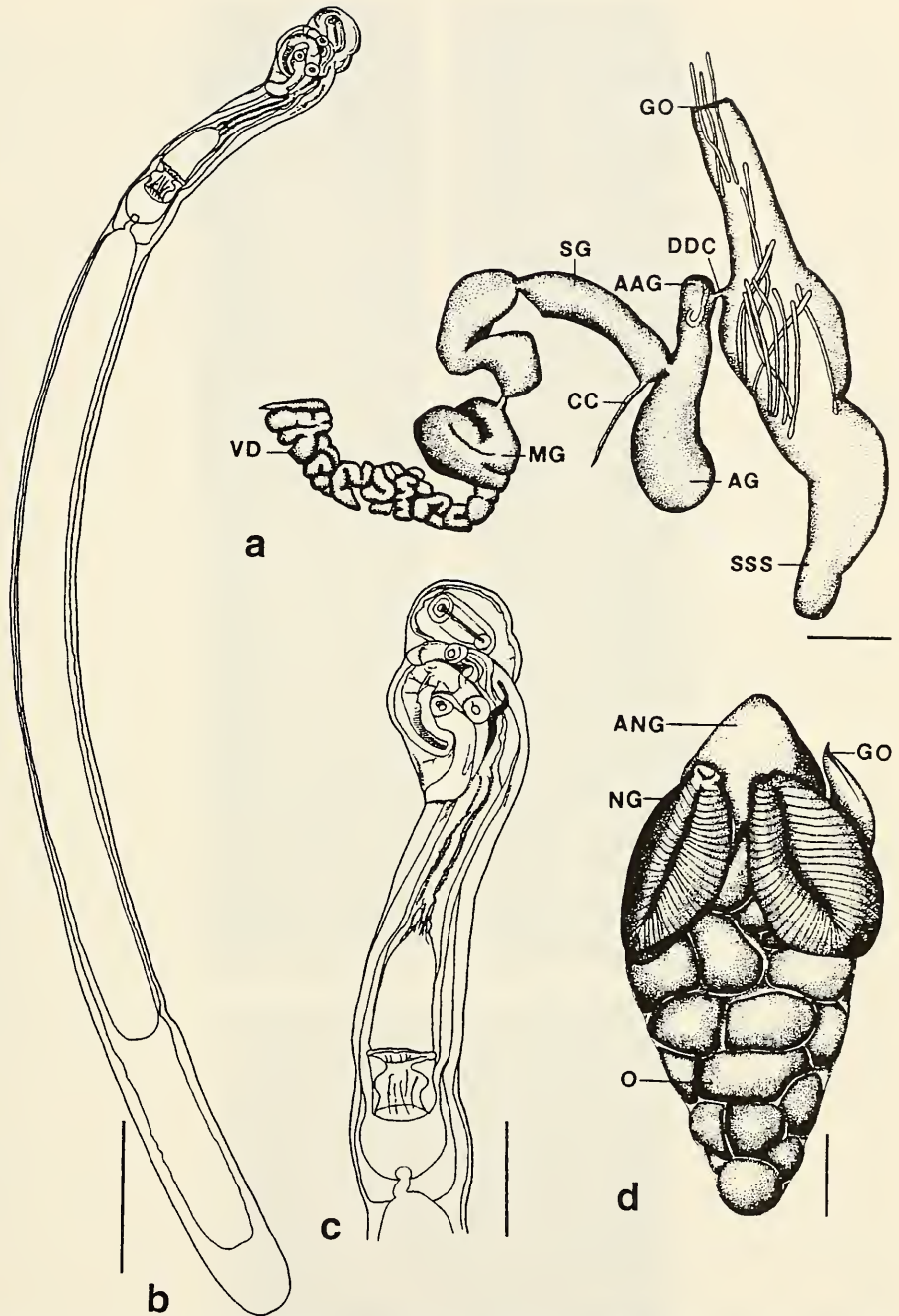


Figure 6. *Sepia mira*: (a) male reproductive tract (testis not shown; spermatophore storage sac containing spermatophores), scale bar 2 mm (AAG — appendix of accessory gland; AG — accessory gland; CC — ciliated canal; DDC — distal deferent canal; GO — genital orifice; MG — mucilaginous gland; SG — spermatophoric gland; SSS — spermatophore storage sac; VD — vas deferens); (b) spermatophore, scale bar 300  $\mu$ m; (c) spermatophore, oral end, scale bar 100  $\mu$ m; (d) female reproductive tract MV F80997, 43.0 mm ML, scale bar 3 mm (ANG — accessory nidamental gland; GO — genital opening; NG — nidamental gland; O — ovary). (a-c male MV F80995, 38.1 mm ML).



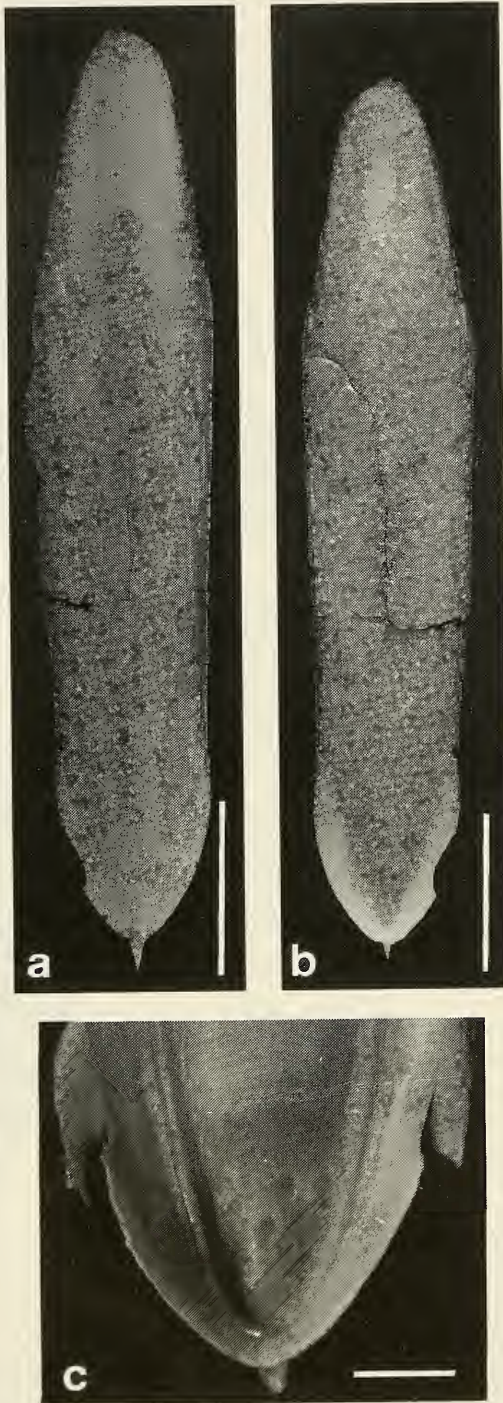


Figure 7. *Sepia mira*: (a) cuttlebone, dorsal view, holotype D10507, 55.0 mm CbL, scale bar 1 cm; (b) cuttlebone, ventral view, same specimen, scale bar 1 cm [photo C. Rowley]; (c) posterior end of cuttlebone, ventral view, AM C306764, 44.0 mm CbL, scale bar 2mm.



glands large, located close together, with narrow, elongate triangular lobes posteriorly, ducts (not shown in figure) connect digestive glands near midline with caecum, ducts with branched attached pancreatic tissue; oesophagus runs dorsally along median junction of digestive glands, joins sac-like stomach immediately posterior to digestive glands; caecum disc-like, grooved in a blunt V-shape anteriorly, surface lining finely pleated; intestine undifferentiated; ink sac very large, elongate; anal flaps well developed.

Male reproductive tract: testis on left posterior side of visceropericardial coelom; at distal end, convoluted vas deferens opens into broad, cone-shaped mucilaginous gland, then narrower, curved, spermatophoric gland (Fig. 6a). Close to junction with lobe-shaped accessory gland and gland appendix, delicate ciliated canal joins spermatophoric gland; distal deferent canal connects appendix of accessory gland to spermatophore storage sac; genital orifice opens dorsal to left gill in anterior end of mantle cavity. Spermatophores: cement body bipartite (Figs 6b and 6c); aboral end rounded, bulbous, connects to sperm reservoir via narrow duct; oral end of cement body cone-shaped, approximately twice length of, and slightly narrower than aboral end, connects to aboral end via long neck, tapers toward oral extremity of cement body; middle tunic commences along aboral part of cement body; ejaculatory apparatus coiled, extends into oral dilation of spermatophore. Spermatophores 2.8–3.0 mm long, 0.12–0.16 mm wide; SpLI 6.6–7.0–7.9 (SD, 0.8); SpWI 4.14–5.06–5.71 (SD, 0.82). Smallest male with well developed spermatophores in Needham's sac is 38.1 mm ML.

Female reproductive tract: ovary hangs medially from dorsal wall of posterior visceropericardial coelom. Oviduct thin-walled, continuous with body cavity; distally with thickened, glandular walls (oviducal glands). Nidamental glands in mature animals occupy large portion of ventral side of mantle cavity. Accessory nidamental glands anterior to nidamental glands (Fig. 6d). Eggs oval; 2.5–3.2 mm long; EgLI 5.8–6.6–7.3 (SD, 1.0). Smallest female with eggs in ovaries is 43.0 mm ML.

Subdermal cartilaginous layer between cuttlebone and skin absent. Cuttlebone length approximately equal to mantle length; outline oblong (Figs 2, 7 and 8); CbL males 39.9–43.9–47.9 (SD, 4.0), females 45.1–48.3–51.4 (SD, 4.5); CbWI males 22.1–22.6–22.8 (SD, 0.4), females 22.0–22.8–23.7 (SD, 1.3); not strongly convex in lateral view; CbBI males 7.0–7.1–7.3 (SD, 0.2), females 5.8–7.0–7.0 (SD, 1.1). Bone bluntly rounded anteriorly; bluntly rounded posteriorly; not strongly recurved ventrally. Dorsal surface pinkish laterally (see remarks); evenly convex; granulose, calcified dorsally, particularly posteriorly (not as pronounced on flared outer cone). Dorsal median rib absent; lateral ribs absent. Chitin borders lateral and anterior margins of cuttlebone. Spine present, long; SLI males 2.7–3.3–3.6 (SD, 0.5), females 3.3–3.6–3.9 (SD, 0.4); straight, directed dorsally; with ventral keel (Fig. 8b); fine, radiating ribs between outer cone and spine (Fig. 7c). Dorso-posterior end of cuttlebone without median longitudinal ridge anterior to spine. Striated zone convex (with narrow, flat margins, Fig. 8b); StZI males 63.9–66.7–69.6 (SD, 2.9), females 67.2–70.0–72.8 (SD, 3.9). Last loculus convex (strongly convex immediately anterior to striated zone, becoming flat posteriorly); LoLI males 21.0–26.8–30.5 (SD, 5.0), females 20.2–25.5–30.8 (SD, 7.5); at midline half length of striated zone (approximately), LoL/StZ(%) males 30.2–40.3–45.7 (SD, 8.8), females 27.1–36.5–45.9 (SD, 13.3); loculus extends posteriorly as narrow margin on each side of striated zone. Sulcus extends entire length of cuttlebone; shallow, narrow (indistinct, visible only in large specimens); not flanked by rounded ribs. Last loculus with shallow median indentation, not very pronounced. Anterior striae broad inverted U-shape to straight (Fig. 8a). Limbs of inner cone extend anteriorly to approximately halfway along striated zone. Inner cone lateral limbs overlie calcareous striated zone anteriorly, extreme anterior tips bordered, separated from outer cone by striated zone. Inner cone limbs strap-like anteriorly, narrower posteriorly; raised, separated from striated zone to form rounded ledge posteriorly; thickened (Fig. 7c). Inner cone without irregular calcareous ribs posteriorly. Outer cone calcified; narrow anteriorly, broadens posteri-

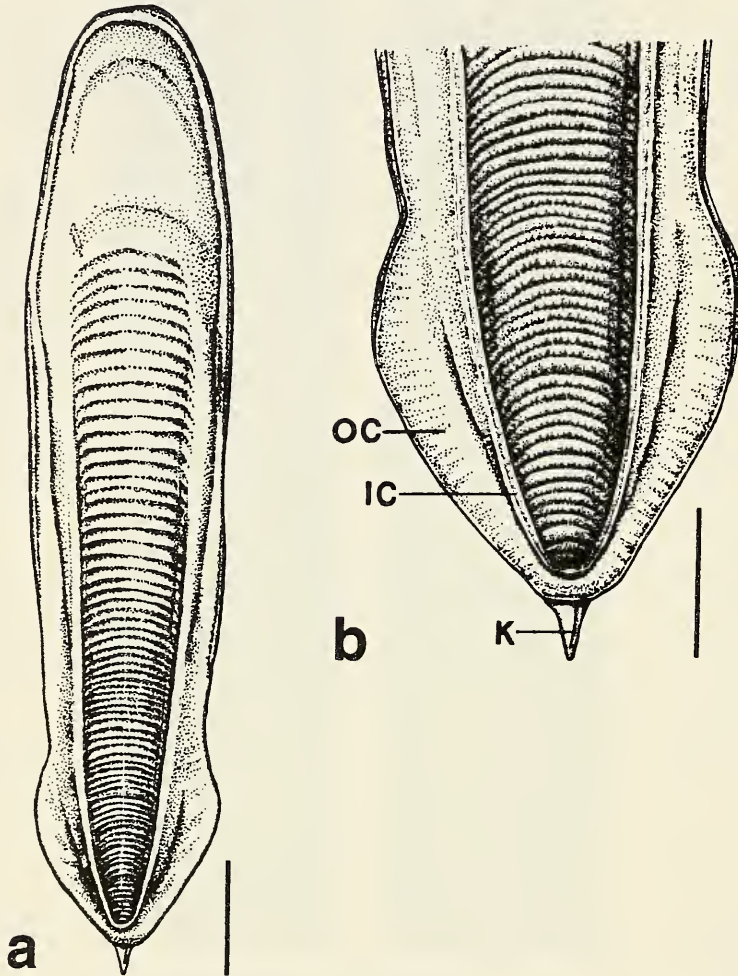


Figure 8. *Sepia mira*: (a) cuttlebone, ventral view, MV F80998, 37.3 mm CbL, scale bar 5 mm; (b) posterior end of cuttlebone, ventral view, same specimen, scale bar 3 mm.

only; lateral limbs flared ventro-laterally; limbs continue as narrow ledge ventral to spine (swollen slightly to cover posterior end of inner cone).

Body papillae present (visible on a single specimen only); dorsal mantle with scattered short longitudinal ridges concentrated mid-dorsally and in a single row close to fins; ventral mantle without ridges. Head and arm papillae absent. Colour: head, arms and dorsal mantle reddish brown (some dull orange spots below chromatophores); paired dorsal eye spots absent. Fins pale; without markings at base. Body without ventral pigment. Distinctive pigment spots on ventral side of club, spots in radiating rows extending from central region towards ventral margin (Fig. 4c). Mantle ridges orange-pink in colour.

#### Type locality

Queensland, North-West Islet, Capricorn Group, 23°18'S 151°42'E.

## Type

Holotype by original designation. SAM: D10507. Cuttlebone only, 55 mm CbL.

## Distribution

Queensland, Lizard Is., 14°40'S 145°28'E — Trial Bay, 30°53'S 153°04'E (cuttlebones); New South Wales, Clarence R., 29°19'S 153°29'E — off Woolli, 29°49'S 153°27'E (entire animals) (Fig. 9); depth range 72–20 m.

## Remarks

Contrary to Cotton's (1932) original description, a very faint sulcus was seen in large specimens examined in this study. As Cotton (1932) described, the sulcus cannot be seen on the type specimen (Fig. 7b), possibly due to wear on the ventral surface of this beach-collected cuttlebone. In other respects, the cuttlebones examined here do not differ from the original description. Adam and Rees (1966) report the absence of a keel on the spine, but a ventral keel is clearly present in this species. The dorso-lateral sides of the cuttlebone are pinkish in freshly preserved animals, but this colour is lost in specimens that have been stored in ethanol.

Of the three male specimens collected, the spermatophores were well developed in one specimen only (MV F80995). The modification of the left ventral arm could be seen only in this specimen. The arms of this animal are not in very good condition, so the details of the modification of the hectocotylus needs to be confirmed when more material is available. In particular, as a number of suckers are missing from this specimen, it is difficult to determine the relative sizes of the suckers in the modified region.

It is not possible to ascertain whether the folding of the posterior half of the tentacular club, seen in all specimens, is an artefact of preservation, or if this is characteristic for the species. It has not been observed in other species of sepiids examined by the author.

The five animals upon which the above description is based were collected from a narrow geographic range off the northeastern coast of New South Wales (Fig. 9). Cuttlebones have been collected at considerable distances north of this region, suggesting that the distribution of this species may be more extensive than that indicated from the complete specimens, though the bones may have drifted some distance to these locations. The small size of the species possibly accounts for the absence of material from museum collections until now. It may be escaping trawl nets, or be of insufficient interest to most collectors to be retained.

Determination of the relationships of *Sepia mira* to other species is at present difficult owing to the general lack of knowledge about the phylogeny of the sepiids. Khromov et al. (in press) have suggested that *S. mira* belongs to the 'doratosepion' species complex. This name is based on Rochebrune's (1884) generic name *Doratosepion*, though the validity of this genus has generally been rejected. The 'doratosepion' species complex (which may or may not be monophyletic) includes those species with an elongated body, short arms with biserial suckers, short tentacular clubs with unequal suckers, and a narrow elongate cuttlebone with two posterior 'wings' and a spine (Roeleveld 1972). In addition to the presence of biserial suckers on some or all of the arms, doratosepia often have modified arms in one or both sexes, some pairs may be elongate, tapering to a very narrow threadlike tip, or differ in sucker arrangement to the remaining arms. Most members of the group show sexual dimorphism. While sharing with members of this complex an elongated body, narrow bone, U-shaped inner cone, and unequal club suckers, *S. mira* does not have any distinctive modification of the arms (though they are short) or arm suckers, and little sexual dimorphism is evident. The outer



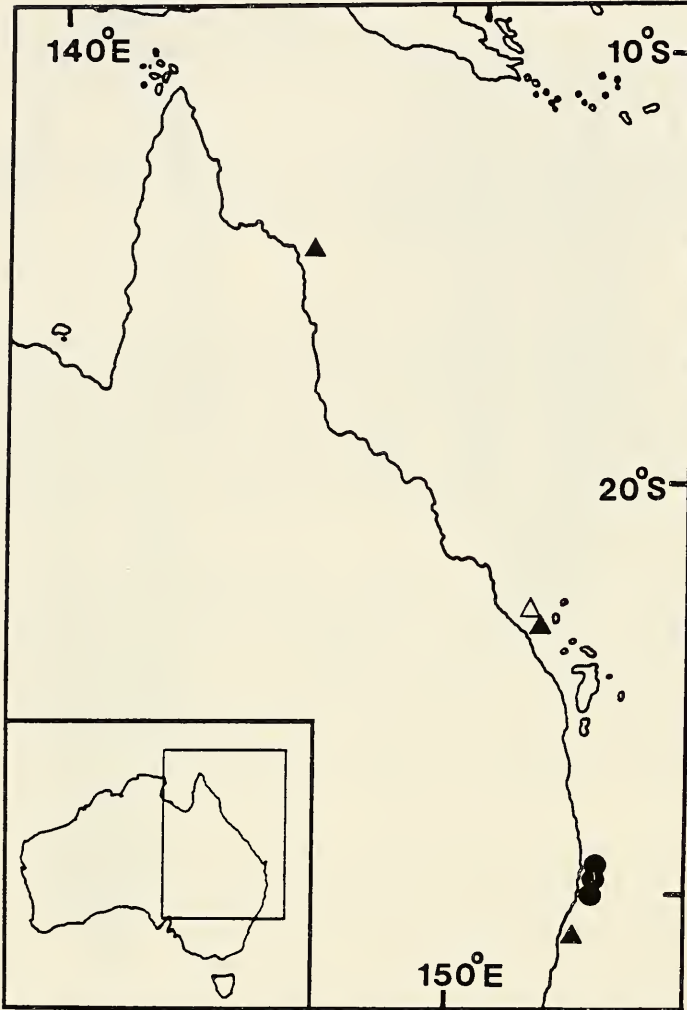


Figure 9. Distribution of *Sepia mira*. Triangles indicate collection localities for cuttlebones only, circles indicate whole animals. The open triangle shows the type locality.

cone in *S. mira* has been described as consisting of two long 'wings' (Adam and Rees 1966), though, as these authors acknowledge, they do not form a recurved 'cup-like' expansion as is often seen in other narrow-boned species. The outer cone 'wings' are usually shorter in these species than in *S. mira*, though the outer cone 'wings' of *S. elongata* d'Orbigny 1845 from the Red Sea (figured in Adam and Rees (1966), Pl. 21, Fig. 132) are not dissimilar in appearance to those of *S. mira* in ventral view. Many species with broad cuttlebones, and therefore not included within the 'doratosepion' species complex, also have a ventro-laterally flared posterior outer cone.

According to Cotton (1932), *S. mira* shows some affinity to a species described by Iredale (1926) as *Decorisepia*, type species *S. rex*. Though not stated in the original description, the reason for this may be that *S. mira* and *S. rex* both have a very narrow inner cone and, were thought to lack a sulcus (though a sulcus is present in both species).



*Sepia rex* differs greatly from *S. mira* in many other respects; the bone is much wider, has dorsal ribs and differs in shape, the club suckers are all small and arranged in 10–12 transverse rows, and the animal is much larger, ranging up to approximately 10 cm ML. It is unlikely that the two species share close affinities.

Until we develop some working hypotheses of the phylogenetic relationships among the sepiids, the position of *S. mira* and particularly its association with other narrow-boned species remains equivocal.

### ACKNOWLEDGEMENTS

I wish to thank Ken Graham from NSW Fisheries for his interest in collecting and retaining the *Sepia mira* specimens described here, and Ian Loch (AM) for the loan of some of this material. I thank Ken Graham also for providing the photograph of the freshly collected animal and C.C. Lu for the photographs of the cuttle-bone of the holotype.

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### ENDNOTE

*Sepia limata* was misidentified as *S. braggi* Verco 1907 in Graham and Wood (1997), based on the work of Lu (in press) that includes *S. limata* as a synonym of *S. braggi*. Work in progress and in preparation for publication by A. Reid has shown *S. limata* to be valid and distinct from *S. braggi*.